

Virginia City Hybrid Energy Center
Response to Data Request
Bruce Buckheit, Member, Virginia Air Pollution Control Board

Question (Page No. 8):

Examine the fate of the mercury and other metals if waste coal is allowed to be combusted – the mercury and the other toxic metals will not be destroyed in the ego, some will be emitted and the majority will move with the ash in the limestone bed and in the contaminated scrubber limestone. A short memorandum should suffice here and, except for the Hg dispersion issue, I suspect the only hard data may be with a report on how Dominion intends to handle limestone wastes at this facility, how others in the industry manage such wastes and what legal constraints may apply under Federal or state law.

Response:

According to mercury emissions from waste coal have been demonstrated to be less than for washed coal in CFB boilers. Furthermore, utilizing waste coal creates additional environmental benefits, including protecting water quality in southwest Virginia. Mercury and other metals are collected and treated in a highly controlled environment when waste or ROM coal is combusted in the CFB boiler. For this reason, the VCHEC design is superior in the collection of metals than coal washing, which places contaminants back into a slurry pond or waste coal pile. Following combustion, the mercury present in coal or waste coal follows two general pathways: it is either emitted to the atmosphere from the combustion stack or it is captured as part of the solid waste either from the air emissions control system or as the direct residual of combustion (i.e., bottom ash). These two different pathways are discussed separately below.

Fate of airborne mercury emissions

A minimum of ninety-eight percent of the mercury, which is present in waste coal, is collected in control devices and a small fraction (i.e. < 2%) is emitted to the atmosphere. After combustion, mercury in the flue gas is present in three distinct forms, elemental mercury vapor, particle-bound mercury and oxidized mercury (also referred to as divalent, ionic or reactive gaseous mercury). The fate of mercury emissions varies with each of these species.

Elemental mercury is an insoluble vapor that is not readily captured by precipitation nor does it readily react with the soils. It, therefore, tends to stay in the air and disperse with the wind, potentially traveling long distances. Although chemical reactions take place in the atmosphere that can slowly oxidize elemental mercury vapor into forms that more readily deposit, the rate of conversion is so gradual that it can disperse long distances and remain in the atmosphere for up to a year. Studies have shown that, for this reason, most

of the mercury in the air over the United States originates from global sources, with Asia being the major contributor (EPA, 2005a).

Particle-bound mercury forms when divalent mercury in the combustion gas condenses onto the surface of solid particulates. Given that the size distribution of particles from well-controlled power plants are relatively small and the smallest particles offer a greater surface area for mercury to condense, particle-bound mercury can sometimes travel for substantial distances (e.g., 10 km to more than 100 km) before being removed through wet and dry deposition. However, maximum deposition rates typically occur within 10 km of the emission point.

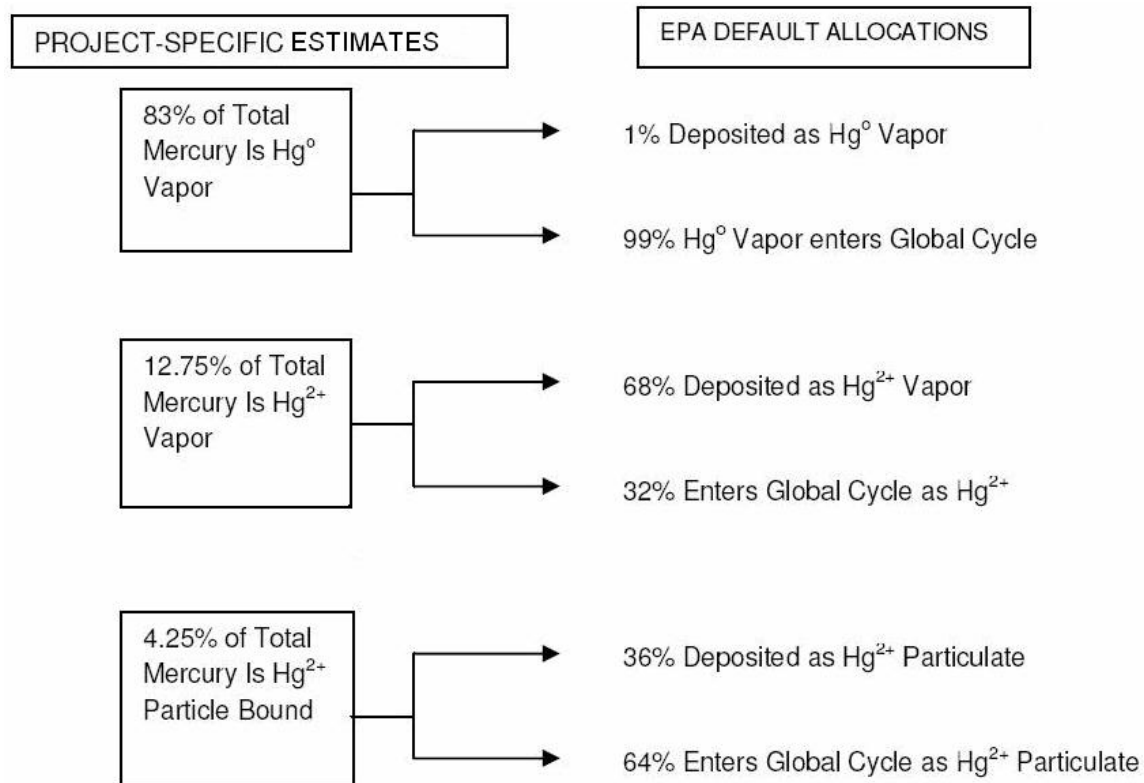
Oxidized mercury vapor is usually in form that is soluble in water and therefore can readily deposit either through dry or wet deposition. As such, this form of mercury is most likely to deposit relatively close to emission sources, depending in part of on the height of the plume above the ground, the type of surface and the frequency of precipitation.

For the Virginia City Hybrid Energy Center (VCHEC) it has been estimated, based on facility design and data compiled by EPRI (2000), that elemental mercury will account for about 83% of the total mercury emissions from the plant. For the remaining 17% of mercury emissions, it is estimated, following EPA (1997, 2005b), that three-quarters of the emitted divalent mercury is vapor and one-quarter is particulate. EPA (1997, 2005b) also provides guidance on the fraction of each mercury species emitted that enters the global cycle (and thus not subject to deposition in the vicinity of an emission source) and the remaining fraction that is subject to deposition.

Table 1 shows that applying this guidance to the estimated speciation of VCHEC emissions indicates that only about ten percent of the plant's mercury emissions will be subject to deposition and about 90 percent will enter the global cycle.

Once mercury is deposited, a portion can be carried through the soil and surface water into streams and rivers where, over time, it can undergo methylation. Water bodies vary substantially in the extent to which deposited mercury is methylated. Factors that can effect methylation include dissolved organic carbon, pH, sulfate concentration, acid neutralizing capacity, wetlands or other hydric soils. Methylmercury accumulates through aquatic food webs such that highest levels are in large predatory fish and fish-eating (piscivorous) animals. As a result, measured methylmercury levels in large fish can be as high as 1 – 10 million fold higher than measured levels in water. The extent of bioaccumulation is highly variable and hard to predict from one water body to another. It depends on many factors, including the length of food chain and what organisms live in the water.

Table 1 HHRAP Phase Allocation and Speciation of Mercury in Air



The potential that mercury emitted to the air could result in impacts to water quality and fish body burdens has been explored in a worst-case assessment of mercury deposition and fate in the Clinch River and its watershed using US EPA methods (see response to Thomson comment #5, see below).

Fate of mercury in solid waste

A substantial fraction of the mercury present in the coal combusted at the VCHEC will be captured as solid waste. Major solid waste streams will include ash from the combustion chamber (i.e., bottom ash) and particulates scrubbed from the flue gas prior to emission to the atmosphere. In general, the mercury present in the waste products is tightly bound to the particulates and does not leach well into water that might contact the solids. This conclusion is supported by several recent studies (e.g., Hensman, et al., 2007 and Princiotta, 2006). This conclusion has also been confirmed within the specific context of the VCHEC by the testing of solid waste from similar facilities using similar coal supplies. The studies of leaching behavior are designed and executed to ensure efficient contact between the solid waste and the water. For example, the solid waste is ground to ensure efficient extraction. In reality, to the presence of lime, the solid waste from VCHEC will very quickly harden and assumes a consistency of set concrete. This

behavior will limit greatly the ability of water to leach metals relative to the laboratory tests.

Most importantly, solid waste derived from the combustion and emissions control process will be managed to limit contact with the environment and minimize any potential effects. Solid waste from the facility will be stored in a secured landfill designed and permitted to control runoff either to groundwater or surface waters. The design and operation of the landfill will be consistent with relevant local, state, and federal regulations and will be overseen by the Virginia Department of Environmental Quality (VDEQ). While the landfill will be operated to minimize contact of the waste with rainwater, some contact is inevitable. For this reason, contact stormwater from the landfill will be subject to treatment to remove metals, particulates, and other relevant pollutants. The discharge of stormwater from the landfill will be done under a Virginia Pollutant Discharge Elimination System (VPDES) permit issued and overseen by VDEQ. The primary goal of this permit will be to ensure protection of the receiving water quality by maintenance of the relevant Water Quality Standards, including that for mercury.

In summary, solid wastes derived from the coal combustion process are relatively poor sources of metals including mercury. The solid wastes will be disposed of in a secure landfill that is managed to limit migration from the solids. The release of noncontact stormwater from the landfill will be controlled, treated, and discharged under VDEQ oversight and permit.

The fate and transport of combustion by-products of coal should be compared with the adverse impacts from leaving the waste coal in place as described in responses to comments 5, 6 and 7.

References:

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